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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/916,734	07/26/2001	Kevin G. Donohoe	6047-59153	1468

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EXAMINER	
MACKEY, TERRENCE M	
ART UNIT	PAPER NUMBER
1765	6

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/916,734	Applicant(s) DONOHOE ET AL.	
	Examiner Terrence Mackey	Art Unit 1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on 3 .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-8, 12-29, and 35-45 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-8, 12-29, and 35-45 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Specification

The disclosure is objected to because of the following informalities: The description of Figure 3A does not reference item 305 and the description of Figure 3B does not reference items 303 and 305.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1 – 8, 12 – 16, 18 – 21, 23 – 29, 35, and 37 – 40, 42 – 44 are rejected under 35 U.S.C. 102(b) as being anticipated by Nambu, US 6,136,722. Applicant claims a method for anisotropically etching a substrate assembly comprising forming a resist layer on the substrate assembly, defining patterns in the resist layer by removing portions of the resist layer, and exposing the resist layer and the surface of the substrate assembly to a plasma etch and simultaneously etching a portion of the substrate exposed by the step of removing portions of the resist layer and increasing the thickness of the resist layer with the plasma etch. Dependent claims include

limitations wherein the etch plasma is generated using a fluorinated, chlorinated, or hydrogenated hydrocarbon gas, using a resist layer of less than about 600 nm thickness, and forming a high aspect ratio etched feature whose depth is five times the resist layer thickness. Applicant also claims a method for plasma etching an oxide layer formed on a silicon wafer, the oxide layer partially covered with a patterned layer of a resist, by exposing the oxide layer and the patterned layer of resist to a plasma formed using an etchant gas consisting essentially of CH_2F_2. Dependent claims include limitations wherein the selectivity of oxide versus resist is at least 5:1 and furthermore at least 10:1 and also wherein the aspect ratio of an etched feature formed in the oxide layer is at least 10:1.

Nambu discloses a plasma etching method for making a hole in a masked silicon oxide layer. The etchant gas may be selected from various saturated and unsaturated aliphatic hydrocarbons with CH_2F_2 being a preferred etchant gas (see column 4, lines 42-47 and reference the entire specification). Nambu discloses on column 6, lines 13-25, using resist layers thinner than 0.5um with a lower limit to the resist thickness of approximately 0.2um. In the third example, openings are created in a 0.5um thick photoresist film formed over an oxide layer resisting on a silicon wafer. Contact holes etched in the 2.1um thick oxide layer may have an aspect ratio approaching 17.5 (see column 11, lines 64-65 and reference the entire specification). Various plasma etching apparatuses may be used including a magnetron plasma etcher (column 5, lines 13-21). Figures 3 and 4 illustrate that selectivity between the oxide layer and the photoresist of at least 5:1 is obtained using a range of process conditions. Nambu discloses that a

polymer film is deposited on the top surface of the photoresist thus increasing the effective thickness of the photoresist since both may be composed of a carbon-based polymer.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 17 is rejected under 35 U.S.C. 103(a) as unpatentable over Nambu '722 in view of Trapp et al., US 6,451,705. Nambu '722 teaches the previously described steps for plasma etching an oxide layer to form a high aspect ratio feature therein, however the reference does not teach the step of plasma etching the substrate regions not covered by the resist with a second halogenated hydrocarbon containing gas that etches the surface of the substrate and the resist layer. Trapp et al. teach a plasma etching method utilizing the height difference between the bottom portion of an etched feature and the surface of the substrate to selectively deposit a self-aligning mask layer relative to the etched feature to extend the depth of the etched feature to a depth that the nominal photomask thickness cannot support. The self-aligned masking layer is

formed through the use of a polymerizing gas of which fluorocarbons and hydrofluorocarbon and chlorofluorocarbons are exemplary. The feature can be etched by repetitively depositing the self-aligned masking layer and etching until the desired depth for the feature is obtained.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use the self-aligned masking process taught by Trapp et al. in the process of Nambu to reduce number of process step involved in the formation of high aspect ratio contact holes a in an oxide layer formed on a silicon substrate.

Claim 22 is rejected under 35 U.S.C. 103(a) as unpatentable over Nambu '722. Nambu '722 teaches the previously described steps for plasma etching an oxide layer to form a high aspect ratio feature therein, however the reference does not teach applicant's claimed step of selecting a flow rate of the etchant gas so that an exposed portion of the substrate is etched without thinning the resist. However is it inherent in the process of Nambu that the flow rate of etchant gas would be selected to provide a desired deposition rate of polymer onto the top surface of the photoresist and thus control the rate of thinning thereof.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to optimize the flow rate of the gas or gas mixture of the plasma etching process of Nambu in accordance with the desired polymer deposition rate and hence the combined thickness of the resist layer with the polymer film deposited thereon.

Claim 36 is rejected under 35 U.S.C. 103(a) as obvious over Nambu '722 in view of Trapp et al., '705 and further in view of Nulty, US 5,562,801. Nambu and Trapp teach the previously described steps for plasma etching a feature in a substrate having an oxide layer and a resist layer thereon with a selectivity of oxide to resist being at least 10:1, however neither reference teaches the use of a getter during the plasma etching process. Nulty teaches on column 10, lines 28-49, that providing a polysilicon layer on the substrate will have a gettering effect on F ions generated in the etching process and improve the selectivity thereof. It is also noted that Trapp et al. teach maintaining the roof temperature of the plasma etcher at 140 C (see column 11, lines 7-8). Furthermore it is noted that Nulty teaches that the tapering of the etched feature may be controlled through the selection of the substrate temperature during etching.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the use of a getter as taught by Nulty to the plasma etching process taught by Nambu in view of Trapp et al. to provide improved selectivity between oxide and resist and optimize the substrate temperature to improve control over tapering of a feature etched in an oxide layer through a plasma etching process. One of ordinary skill in the art would be motivated to optimize result-effective variables of the plasma etching process in order to produce a desired result [In re Boesch, 617, F.2d 272, 205 USPQ 215 (CCPA 1980)].

Claim 41 is rejected under 35 U.S.C. 103(a) as unpatentable over Nambu '722 in view of Trapp et al., US 6,451,705. Nambu '722 teaches the previously described steps for plasma etching an oxide layer to form a high aspect ratio feature therein, however the reference does not teach the step of plasma etching the substrate regions not covered by the resist with a second halogenated hydrocarbon containing gas that etches the surface of the substrate and the resist layer. Trapp et al. teach a plasma etching method utilizing the height difference between the bottom portion of an etched feature and the surface of the substrate to selectively deposit a self-aligning mask layer relative to the etched feature to extend the depth of the etched feature to a depth that the nominal photomask thickness cannot support. The self-aligned masking layer is formed through the use of a polymerizing gas of which fluorocarbons and hydrofluorocarbon and chlorofluorocarbons are exemplary. The feature can be etched by repetitively depositing the self-aligned masking layer and etching until the desired depth for the feature is obtained.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use the self-aligned masking process taught by Trapp et al. in the process of Nambu to form a high aspect ratio feature of the desired depth into the substrate.

Claim 45 is rejected under 35 U.S.C. 103(a) as unpatentable over Nambu '722. Nambu '722 teaches the previously described steps for plasma etching an oxide layer to form a high aspect ratio feature therein, however the reference does not teach

applicant's claimed step of selecting a flow rate of the etchant gas so that an exposed portion of the substrate is etched without thinning the resist. A start-up loss of resist prior to the formation of a protective polymer film thereon is inherent in the plasma etching method of Nambu.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to optimize the process conditions such that the start-up loss of the resist layer would be optimized to applicant's claimed start-up loss of less than 20 times the nominal thickness of the resist layer.

Conclusion

Remaining references cited of interest to show the state of the art.

No claim is allowed.

Papers relating to this application may be submitted to Technology Sector 1700 by facsimile transmission. Papers should be faxed to Crystal Plaza 3, Art Unit 1765, using fax number (703) 305-6357. All Technology Sector 1700 fax machines are available to receive transmissions 24 hrs/day, 7 days/wk. Please note that the faxing of such papers must conform to the Notice published in the Official Gazette, 1096 OG 30, (November 15, 1989).

Any inquiry concerning this communication or earlier communications from the Examiner should be directed to Terrence Mackey whose telephone number is (703) 305-5504. The Examiner can normally be reached Monday - Friday from 7:00 AM – 4:30 PM.

If attempts to reach the Examiner by telephone are unsuccessful, the examiner's supervisor, Ben Uteck, can be reached at (703) 308-3836.

Any inquiry of a general nature or relating to the status of this application should be directed to the receptionist whose telephone number is (703) 308-0661.

ROBERT KUNEMUND
PRIMARY EXAMINER

TMM

April 4, 2003